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METHOD AND APPARATUS FOR SURGICAL TRAINING

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 60/368,458 filed Mar. 28, 2002.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to devices and methods for surgical training, and in particular, to such devices and methods which are useful in training on microvascular and microsurgical procedures on both human and animals.

2. Brief Description of the Related Art

Laboratory training models are essential for developing and refining surgical skills, especially for microsurgery. The closer to live surgery the model is, the greater the benefit. At present, training is limited to artificial models that simulate human anatomy, anesthetized live animals and cadavers, but none of them reliably mimic the anatomy and the characteristics of the vascular tree and tissue in the human and animal anatomy during live surgery, in particular, hemorrhage. Training models using a portion of animal anatomy are known, but even with such a model, training is limited to a few procedures and cannot replicate the experience of "skin-to-skin" procedures, i.e., from opening to closing. Cadaver models injected with colored silicone, gelatin, or any other congealed material lack bleeding, pulsation and fluid vascular filling, which allow manipulation of the vessels, hemostasis, clipping, or suturing. On the other hand, live anesthetized animals do not represent true human anatomy, apart from the ethical considerations involved in the use of live animals in surgical training.

Microsurgery, and especially neurosurgery, demands the development of dexterity and skill for both basic and fine procedures and techniques. In particular, in organs such as the central nervous system or vascular system, the surgeon's individual skills play a crucial role in determining the outcome. Hence, the emphasis has been on laboratory training in preparing people for the operating room experience. (Yasargil M G, *Microneurosurgery, Microsurgical anatomy of the basal cistern and vessels of the brain*. New York: Thieme Medical Publishers, 1984, Volume 1, p. vi). The fine manipulation and dissection of the vessels with anastomosis are usually practiced on live anesthetized animals or artificial models. (Yonekawa Y, Frick R, Roth P, Taub E, Imhof H-G: *Laboratory Training in Microsurgical Techniques and Microvascular Anastomosis*. Oper Tech Neurosurg 2:149-158, 1999.). Unfortunately, these are limited to simple techniques and have no relation to the actual anatomy or surgical crises that are encountered by the trainee in live surgery. A critical part of this training is mastering the anatomy.

To improve the illustrative value of cadaveric dissection, colored materials are injected into the vessels of cadavers to identify the arteries and veins for anatomical studies. Fluorescein and radiopaque substances, silicone, gelatin, latex, acrylic, or tinted polyester resin have been used for this purpose. (Gibo H, Carver C C, Rhoton A L Jr, Lenky C, Mitchell R J: *Microsurgical anatomy of the middle cerebral*

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artery; J Neurosurg 54:151-169, 1981; Sanan A, Abdel Azeiz K M, Janjua R M, van Loveren H R, Keller, J T: Colored silicone injection for use in neurosurgical dissection: anatomic technical note. Neurosurgery 45:1267-1274, 1999; Smith R, Rhoton A L Jr: Comment. Neurosurgery 45:1272-1273, 1999; Umansky F, Juarez S M, Dujovny M, Ausman J I, Diaz F G, Ray W J: Microsurgical anatomy of the proximal segments of the middle cerebral artery. J Neurosurg 61:458-467, 1984; Diaz J: Comment. Neurosurgery 45:1271-1272, 1999.).

Mechanical pressure pumps have been used to introduce and perfuse embalming fluids via the common carotid or femoral arteries (Coleman R, Kogan I: An improved low formaldehyde embalming fluid to preserve cadavers for anatomy teaching. J Anat 192:443-446, 1998; O'Sullivan E, Mitchell B S: An improved composition for embalming fluid to preserve cadavers for anatomy teaching in the United Kingdom. J Anat 182:295-297, 1993.). Mechanical pumps have also been used to introduce liquids into artificial training models or into portions of animal anatomy as described in U.S. Pat. No. 5,425,644 to Szinicz.

In studying the role of neurovascular compression in trigeminal neuralgia, Hamlyn described injection filling of cadaveric vessels to determine the neurovascular relationships in the posterior fossa (Hamlyn P J: Neurovascular relationship in the posterior fossa, with special reference to trigeminal neuralgia. 1. Review of the literature and development of a new method of vascular injection and filling. Clin Anat 10:371-379, 1997.).

Various attempts have been made to preserve living organs using various combinations of pumps, conduits and fluid reservoirs connected to the vascular system of the organ. See, for example, U.S. Pat. Nos. 4,666,425; 5,326,706; 5,494,822; and 3,892,628.

Training models with means to simulate the behavior of blood or other fluids in the human body are known from U.S. Pat. Nos. 6,234,804; 5,951,301; 5,634,797; 5,620,326; 5,320,537; 5,215,469; 4,773,865; 3,027,655; 4,182,054; 2,871,579; 2,752,697; and Published Patent Application U.S.2001/0019818A1. The disclosed devices employ simulations of living anatomy and are generally limited to one or a few procedures. While such models may be valuable in the early stages of training, they are less effective for higher level training in surgical procedures.

U.S. Pat. No. 5,425,644 to Szinicz for a "Surgical Training Apparatus and Method" discloses an apparatus for training in surgical procedures. It includes a pump, tubing, and a fluid-containing reservoir connected to non-living animal tissue, such as organs obtained from a slaughterhouse. The fluid is preferably an approximation to "the physical properties of blood, e.g., in viscosity, density, and color. The fluid flows through the non-living animal tissue and exits to the reservoir from which it is recirculated by the pump. In one embodiment, the pump is a peristaltic flow type to provide a pulsating fluid flow. Alternatively, a fluid interrupter creates a pulsating flow. Pressure gauges may be employed to monitor and regulate the pressure of the circulating fluid.

The references mentioned above are not admitted to be prior art with respect to the present invention. The described references suffer from various limitations, which are overcome by the present invention as described below.

BRIEF SUMMARY OF THE INVENTION

The present invention is a device and method for microsurgical training. Current laboratory training models, while